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Grain Processing for Feedlot Cattle

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Several changes have occurred in the cattle feeding business which have focused attention on grain processing. The first of these was, the arrival of big feedlots provided an opportunity to use larger and more sophisticated processing equipment at reasonable cost per ton of feed produced. Also, the need to minimize feed separation and digestive disturbances encouraged the use of more sophisticated methods of processing.

A second development that is now focusing attention on grain processing is the rapidly increasing costs of equipment, fuel and labor involved in grain processing. In recent years, these have been increasing more rapidly than the cost of feed. When such is the case, it takes larger increases in efficiency to translate into additional profits.

Table I. Relative Importance of Improving Rate of Gain and Feed Efficiency.

	Normal	*10% Improvement*	*Savings (for 300 lb gain)*
	lb	lb	
Rate of gain	3.00	.30	$1.82
Feed/lb gain	7.00	.70	$8.40

Feed is the most costly single item in growing-finishing cattle, often representing 70-80 percent of the total cost of gain. Thus, small improvements in feed efficiency above the cost of obtaining those improvements can translate into sizable increases in net profits. Assuming a total feed requirement of 3,000 pounds per head during the finishing period and a feed cost of $4.00 per hundredweight, then 5 and 10 percent improvement in feed efficiency above cost results in savings of $6.00 and $12.00 per head, respectively. These would translate into 50 and 100 percent greater profit per head, assuming a $12.00 per head feeding return. Ultimately, those differences are reflected in survival in the cattle feeding industry.

An example of the relative importance of rate of gain and feed efficiency is shown in *Table I*. Improving feed efficiency 10 percent has nearly four times as much impact on the cost of gain as does improving rate of gain 10 percent. However, an increase in rate of gain or feed intake is usually reflected in better feed efficiency.

Feed efficiency can be routinely improved by changing the method of grain processing, as much as 3-5 percent for corn and 8-15 percent for milo. Rate of gain is difficult to increase by grain processing. Some methods may reduce gain while improving feed efficiency.

Processing costs must be weighed carefully against values gained through better feed efficiency. Steam flaking vs feeding whole shelled corn improves feeding value of corn 3-5 percent. If corn costs $2.50 per bushel or $4.46 per hundredweight a 4 percent improvement would be worth $.18 per hundredweight or $3.60 per ton. The cost of installing, maintaining and operating a steam flaker might cost this much at today's prices. On the other hand, a feeder using milo could install processing equipment which would bring about a 10 percent improvement in $5.00 per hundredweight milo. This would represent a $.40 per hundredweight or an $8.00 per ton improvement.

Other alternatives must also be considered. The return from a large investment in processing equipment must be weighed against a similar investment in cattle, for example. Small feeders who have limited capital may forego processing equipment which will give a positive return on investment if this return is less than that which could be expected from investment in cattle or other alternative investments.

Selecting a Processing Method

Many processing methods have been developed by past research. Obviously, no single method will be suited for all cattle feeders. Important factors to consider follow:

A. ***Nutritional Considerations.***
   1. Effect on feed intake, rate of gain and feed efficiency -- Will increased cattle performance more than offset any increase in cost?
   2. Effect on feed management problems -- Do the cattle go on feed and stay on feed satisfactorily?
   3. Response of type of grain to processing -- Is efficiency improved?
   4. Uniformity and quality of finished product -- Are amount of fines, separation, palatability, surface area, density or weight per bushel acceptable?
   5. Influence on carcass yield -- Is weight of gut content affected?

B. ***Non-nutritional Considerations.***
   1. Size of feedlot -- Is feedlot large enough to justify investment in processing equipment?
   2. Repair, maintenance and operating cost of equipment.
   3. Labor requirements.

Processing Methods

Approximately 70-80 percent of the dry matter in cereal grains is starch. Starch in some grains is more digestible than in others. Availability of starch even varies from one grain variety to another. Most processing methods have been developed to improve starch availability in cereal grains when the grain is fed to finishing cattle.

Some methods have not been adequately evaluated for the most accurate comparisons. Also it is hard to estimate costs of processing accurately due to the rapid change in costs of equipment and fuel.

Methods of Processing

- ***Whole grain.*** Feeding whole kernel corn is satisfactory when cattle are essentially self fed and weather conditions do not interfere with frequent feed intake. This is true for both high moisture and dry corn, with perhaps the exception of exceptionally dry corn (12 percent moisture or lower).

  Oats also are usually digested well when fed whole. A rather high percentage of most other grains tends to pass through whole without digestion, thus further processing is indicated.

- ***Grinding.*** This is usually done with a hammermill. Factors influencing the fineness of the end product include screen size, hammermill size, power and speed, type of grain and moisture content of grain. Differences in animal performance reported in the literature are likely due to variations in "fineness" of grind in various experiments.

- ***Dry Rolling.*** Grain is passed through rollers which are usually grooved on the surface. Particle size varies from very small to very coarse and is influenced by roller weight, size of grooves, pressure and spacing, moisture content of the grain and rate of grain flow.

- ***Steam Rolling.*** Grain is exposed to steam for one to eight minutes prior to rolling. Sometimes this processing is also known as crimping or steam crimping. The steam softens the kernel, producing a more intact, crimped-appearing product than dry rolling. The moisture content of the grain is also increased slightly. Crimping offers little or no advantage in feed efficiency over grinding or rolling. The value of crimping has been grossly overemphasized. Particle size and physical form of crimped grain may improve palatability and animal acceptance in some instances.

- ***Pelleting.*** Grain is usually ground or rolled before processing through a pellet mill. The primary advantage of this method is in the mechanization of feed handling. Little or no economic advantage exists for pelleting over grinding or rolling, even though feed efficiency is improved in some cases. Benefits of pelleting seldom, if ever, can be expected to cover the cost of pelleting in complete rations.

- ***Steam Flaking.*** This was the first "modern" technique which markedly increased feed efficiency and rate of gain in the case of milo. Grain is subjected to steam under atmospheric conditions for usually 15 to 30 minutes, before rolling. Large, heavy roller mills set at near zero tolerance produce a very thin, flat flake which usually weighs from 22 to 28 pounds per bushel and contains 16 to 20 percent moisture. The flaking process causes gelatinization of the starch granules (hydration or rupturing of the starch molecule) rendering them more digestible. The degree of flaking and level of gelatinization appear to be influenced by such factors as steaming time, temperature, grain moisture, roller size and tolerance, processing rate, and type and variety of grain.

- ***Pressure Flaking.*** The grain is subjected to steam under pressure for a short time, such as 50 pounds per square inch for one to two minutes. The continuous flow cooker is operated by air lock valves to inject and eject grain. Steam is injected into the cooker at the desired pressure. The grain in the chamber reaches a temperature approaching 300° Fahrenheit. When the grain is expelled from the cooker it is generally cooled (by use of a cooling and drying tower) to below 200° Fahrenheit and 20 percent moisture before flaking. Flakes produced from this method may be less brittle and less subject to fragmenting during the mixing and feeding operation than those from steam flaking.

- ***High-Moisture Harvesting.*** Grain is harvested and stored at 20 to 30 percent moisture. Cereal grains are physiologically mature when the moisture content of the grain drops below 38 to 40 percent. High moisture harvested grain may be ground and stored in a horizontal silo or in the whole form if oxygen-limited storage is used. Whole grain cannot be packed adequately to avoid substantial spoilage in horizontal silos.

- ***Reconstituting.*** Dry grain is reconstituted to 25 to 30 percent moisture and stored whole in oxygen-limited conditions for 10 to 20 days before feeding. Grain should be stored whole and then rolled or ground before feeding in order to obtain the desired improvement in feed utilization.

- ***Chemical Preservation.*** Acids, usually propionic or a combination of propionic and acetic are added to moist, early-harvested grain to permit storage of the whole kernel wet grain in conventional facilities, such as wooden bins or trench silos. The wetter the grain the more acid is required for satisfactory preservation; thus, the expense of preservation increases with the increase in moisture content of the grain. This method is used in conjunction with high- moisture-harvesting programs and should not be confused with reconstitution.

- ***Popping.*** Air-dry grain with a moisture content of 10 to 14 percent is popped by heating it with high temperature air at 700-800 degrees Fahrenheit for 15 to 30 seconds. Not all of the grain pops, but the resulting product very much resembles ordinary popcorn and has a moisture content of approximately 3 percent. Popping causes disruption of the starch granules by using natural moisture in the kernel to steam, gelatinize and expand the starch granules. RoIling and remoisturization are usually essential.

- ***Micronizing.*** Dry grain which has been heated with gas-fired, infrared generators as the grain passes along an oscillating steel plate or skillet and then dropped into Knorling rolls has been termed micronized grain. The term was coined from the word microwave (microwaves are emitted from the infrared generators) and from the unique type of rollers used. The grain is discharged at the end of the plate at about 300 degrees Fahrenheit. The rolls have a spiral groove which places high diagonal and parallel pressure on the grain. The product has an intact, flake-like appearance, very much resembling some steam-flaked grains. Temperature of the grain and density of the final product can be regulated. Densities of micronized grain normally range from 18 to 30 pounds per bushel; approximately 25 pounds per bushel has been recommended.

- ***Exploding.*** This technique involves delivering raw grain into high tensile strength steel "bottles" which hold approximately 200 pounds of grain. Live steam is injected into the bottles until pressure reaches 250 pounds per square inch. After about 20 seconds, a valve opens to let the grain escape as expanded balls with the hulls removed. Under the high pressure, moisture is forced into the kernels, which, when released into the air, swell to several times their original size. The product resembles puffed breakfast cereals.

- ***Extruding.*** Extruded grain is produced by a machine which applies heat and pressure by means of friction as the grain passes through a tapered screw. Dry whole grain, with no moisture added, is crushed by an auger-like rotor and forced through an orifice, producing "ribbons" which break into flakes about 1/32 inch in thickness. Various factors, including moisture of the grain, influence the character of the final product.

- ***Roasting.*** Grain is passed through a roaster of the type used for soybeans. The grain is heated to about 300 degrees Fahrenheit and has a roasted odor with an oily, puffed and slightly caramelized appearance.

Choice of Processing Technique

Choice of processing technique is highly dependent on the cereal grain to be fed. A given processing technique may be very desirable for one grain, but quite detrimental to another. Corn may be fed without any processing, but not milo. Pressure treating appears to be desirable for milo, but harmful to wheat.

Comparison of grain processing techniques is difficult because there are a number of interactions between processing technique and roughage level or type of ration fed. To illustrate this problem, data from Ohio State University has shown that whole shelled corn was superior to crimped corn in very low roughage rations, whereas crimped corn was clearly superior in high roughage rations.

Such interactions cause results on new grain processes to be biased by the kind of control ration fed. Consequently, feeders should consider only those comparative tests which have involved rations and conditions very similar to those they intend to use in their own feeding program.

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